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Travel Well Quality Criteria v1

Public Report

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Executive Summary

In the project description, the D2.1.1 is described as the following:

“Quality criteria that will enable repository owners and content developers/publishers in both the public and private sector to identify learning resources that have the potential for cross-border use.”

Before presenting a validated set of quality criteria, this deliverable first presents an overview of the previous work in the field of quality criteria for digital educational content. Such quality criteria are widely applied to enable learning object repository (LOR) owners and content developers/publishers in both the public and private sector to identify reusable learning resources of high quality.

However, the current criteria seldom address the potential for cross-border use of learning resources, i.e. when the learning resource and its end-user (e.g. learner, teacher) come from different countries and/or do not share the same language.

This report attempts to combine two different approaches to better gauge the learning resources potential for cross-border use:

- quality criteria proposed by project partners in Ministries of education (top-down)
- the contextual social information derived from the real usage of the resources (bottom-up)

Based on previous work and new concepts presented here, this deliverable offers the first version of a eQnet quality model that can be used to start the process of validating it with the wide set of users across Europe who are within the project represented by the WP3 - teachers network.

D2.1.2, due in March 2011, will present the first reflections from teachers validation work, and eventually, the version 3 at the end of March 2012 will offer the validated set of travel well quality criteria.

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Before presenting a validated set of quality criteria, this deliverable first presents an overview of the previous work in the field of quality criteria for digital educational content. Closely related to this topic is also the Deliverable 2.21 “State of the Art report LT” where eQNet partners’ quality standards for digital learning resources are presented. This type of quality criteria are widely applied to enable learning object repository (LOR) owners and content developers/publishers in both the public and private sector to identify reusable learning resources of high quality.

However, the current criteria seldom address the potential for cross-border use of learning resources, i.e. when the learning resource and its end-user (e.g. learner, teacher) come from different countries and/or do not share the same language.

Based on the review and new reflections, this deliverable offers the first version of a eQnet quality model that can be used to start the process of validating it with the wide set of users across Europe who are within the project represented by the WP3 - teachers network.

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1 Introduction to the notion of learning resources that “Travel well”

In recent years technical architectures have been put in place to enable better discovery of digital learning resources. The interconnection of learning resource repositories (and federations of repositories) is happening at the European level (e.g. Learning Resource Exchange¹, Ariadne Foundation²) and an international level (e.g. the GLOBE initiative³). Increasingly, therefore, and maybe without even being aware that this is happening, users will search across networks of linked learning resource repositories and find resources that were designed primarily for a national rather than international audience and that were originally produced for a specific local/national curriculum and educational context.

Currently, we do not know how well this will work for users (particularly for the “average” teacher who may not have a high level of ICT competence/confidence). Mechanisms can, of course, be put in place to enable users to easily filter out resources that, for example, are not in their own language. However, this sort of filtering can be a very blunt instrument and ignores the fact that some teachers may be able to successfully use or adapt resources developed elsewhere including some that are not in a language that they speak.

The key aim in the Quality Network for a European Learning Resource Exchange (eQNet), therefore, is to look at mechanisms that would make it easier to identify and exchange learning resources that could ‘travel well’ and be used in different cultural, learning or curriculum contexts.

The main challenge is to understand how does the notion of “travel well” differs from the conventional understanding of “quality” of learning resources, and how to identify methods for selecting “travel well” resources from large pools of data.

In the eQNet project we combine two separate approaches that have gained ground in the field:

- established quality criteria and control (top-down) normally applied by ‘experts’
- criteria derived from the activities of individual users who use and interact with learning resources on the portal (bottom-up)

Below we first define the terms used within this project. Section 2 looks at the previous work in the field from the above-mentioned two different approaches, top-down and

¹ <http://lreforschools.eun.org>

² <http://www.ariadne-eu.org/>

³ <http://www.globe-info.org/>

bottom-up. Section 3 outlines the upcoming work in the eQNet project regarding Travel Well Quality Criteria.

1.1 What do we mean by ‘learning resource’?

In the literature, digital learning resources are often times referred to as *Learning Objects* or *Open Educational Resources*. A Learning Object (LO) can be understood as “any digital resource that can be reused to support learning” (Wiley, 2000). In the eQNET project we are also dealing with ‘open’ educational resources from Ministries of Education and other stakeholders. Open Educational Resources (OER) have been defined by Hewlett Foundation, which has funded many OER projects:

“OER are teaching, learning and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials or techniques used to support access to knowledge.”

1.2 What do we mean by ‘travel well’?

The term ‘travel well’ as applied to learning resources has been used by European Schoolnet for a number of years as a convenient shorthand to describe content that can be used by teachers in different countries. Writing in January 2004, Dr. Bálint Magyar, the then Hungarian Minister of Education argued that European countries needed to investigate the barriers and possibilities of sharing educational resources and suggested that the transferability of content from one country to another was both possible and necessary:

“Is the educational content developed in one culture transferable to another different educational system to reduce costs and widen the content market? International surveys based on common curriculum content show that there is a significant body of knowledge considered basic that constitute a compulsory part of education all over the world. Science, math education and foreign language learning are most evident references, but successful international assessment projects in social science, arts and literature provide ample evidence for the existence of a common ideal of erudition in more culture-specific disciplines. Educational software does travel well. ”

1.3 What do we mean by ‘quality’?

Quality evaluation is defined as “the systematic examination of the extent to which an entity (part, product, service or organisation) is capable of meeting specified requirements” (ISO/IEC 14598-1:1999, 1999).

While evaluating quality of learning resources we can take into account quality evaluation criteria dealing with technological, pedagogical and intellectual property rights (IPR) issues.

Reusability of learning resources and, in particular, their ability to “travel well” between different education systems, is also considered here as a part of the overall quality of learning resources. This means that any high quality learning resource has *some* reusability potential (or potential to “travel well”), **but this does not mean that any reusable learning resources is necessarily of high quality.**

2 Previous work in the field of quality criteria and travel well

2.1 *Different Approaches to quality evaluation of learning resources*

The provision of learning resources provides better access to quality learning resources and supports enhanced learning outcomes. According to (Haughey, Muirhead, 2005), the purpose of learning resources is to increase the effectiveness of learning by making content more readily available, by reducing the cost and effort to produce quality content, and by allowing content to be more easily shared. These two purposes, **effectiveness and efficiency**, receive different emphases from different sectors.

One of the main criteria for achieving the high effectiveness and efficiency level with learning resources is LO reusability (Kurilovas, 2009a). According to the authors, the need for reusability of LOs has at least three elements:

1. Interoperability: LO is interoperable and can be used in different platforms.
2. Flexibility in terms of pedagogic situations: the LO can fit into a variety of pedagogic situations.
3. Modifiability to suit a particular teacher's or student's needs: the LO can be made more appropriate to a pedagogic situation by modifying it to suit a particular teacher's or student's needs (McCormick et al., 2004).

It can be argued that the reusability criteria has emerged as the most important LO evaluation criteria for the users (Kurilovas, 2009a). The e-learning system's flexibility depends on the level of separating of the 'content' from 'activity' (so-called 'pedagogical decontextualisation') as well as on their reusability level (Dagiene, Kurilovas, 2008, 2007). This is also achieved by separating a LO metadata repository from a LO repositories (where the actual object is stored), each of which can reside on different servers (Kurilovas, Dagiene, 2008). This type of flexible e-learning system design seems to be one of the best e-learning solutions from technological, educational, organisational and socio-economic points of view. The detailed evidence for this statement is out of the scope of this deliverable, but the aforementioned approach ensures the system's pedagogical and organisational flexibility (e.g., high learning personalisation level) as well as the better financial and economic efficiency indicators such as lower resource costs per single user, major financial benefit, less time to buy off⁴, etc. (Kurilovas, 2007).

According to (Haughey, Muirhead, 2005), "the growth in the number of learning resources, the multiplicity of authors, their increasing diversity of design and their

⁴ Less time to buy off" is a typical criterion for evaluating probable success or failure of the investment projects which means that the investments should buy off (i.e., "return", or should generate financial or other benefit) during the reasonable period of time. In the context of learning resources, it means the "other benefit", e.g., that an educational institution while considering to purchase or not a quite expensive resource should take into account such factors as a probable number of students using this resource during one semester, anticipatory educational value of the resource etc.

availability to trained and untrained educators has generated interest in how to evaluate them and which criteria to use to make judgments about their quality and usefulness”.

We can evaluate both (technological) internal quality and quality related to the use of educational resources. According to (Gasperovic, Caplinskas, 2006), internal quality is a descriptive characteristic that describes the quality of software independently from any particular context of its use, while quality in use is evaluative characteristics of software obtained by making a judgment based on criteria that determine the worthiness of software for a particular project. Gasperovic and Caplinskas (2006) consider that it is impossible to evaluate quality in use without knowing characteristics of internal quality.

Any software (learning resources in our case) technological quality evaluation model (set of criteria) should provide the experts (decision makers) the clear instrumentality who (i.e., what kind of experts) should analyse what kind of Learning resources quality criteria in order to select the ones that suitable for their needs (e.g. the particular experts usually consider not the ‘overall’ or ‘general for all cases’ quality of a learning resource, but only suitability of a given resource for their particular case, i.e., their institution’s users, particular project etc.). Software engineering experts should analyse ‘internal quality’ criteria that are based on (or ‘deal with’) scientific knowledge on informatics engineering, and programmers and users (teachers) should analyse ‘quality in use’ criteria that are based on the users’ feedback

2.2 ‘Travel well’ quality criteria from EUN

Here are described findings from a number of European Schoolnet’s content-related projects.

2.2.1 CELEBRATE

A key finding in the CELEBRATE project⁵ was that the ways in which Ministries and content developers tagged learning resources was not necessarily an accurate indication of how teachers actually used the resource in practice. For example, even though the Learning Resource Type might be defined as “drill and practice” according to the metadata, some teachers demonstrated that they could use the resource for collaborative learning.

“It is possible to conclude, on the basis of the evaluation evidence, that it is possible to support a constructivist or advanced pedagogy through the use of Learning Objects (Learning resources), but that this is more likely to be a feature of a teacher’s classroom than the LO. Clearly the LO type may have some impact on this (i.e. it has affordances), but it is evident that even the most apparently ‘non-constructivist’ or ‘non-advanced’ LO (e.g. Drill and practice) could be used as part of advanced pedagogy, if the teacher has the skill of use and the repertoire of approaches in her teaching.”

CELEBRATE Evaluation Report, Prof. Robert McCormick et al, Nov. 2004

⁵ <http://celebrate.eun.org>

Looked at another way, even though an author or content developer might favour a particular form of pedagogy and consciously attempt to incorporate this into the design of a specific learning resource, teachers might not follow the designers' chosen approach. As their level of ICT competence grows, many teachers may successfully use such a resource within a much wider variety of innovative learning contexts than was originally thought possible.

This project showed that making assumptions concerning what resources will 'travel well' may be problematic. Even if it is possible to agree quality criteria for trans national reusability, it may be best to think of some resources having 'travel well' *affordances*.

2.2.2 MELT

In the MELT project⁶, Ministries of Education and other content providers developed a checklist to help them decide which resources might travel well and should be enriched with new metadata. The MELT checklist was divided into five categories: Pedagogical, Usability, Reusability, Accessibility, Production and was seen more as a minimum framework that should be used in a flexible way. (It was particularly inspired by the framework and quality guidelines provided by the Finnish National Board of Education).

The initial assumption in MELT was that content is more likely to 'travel well' if it is:

- **modular:** the parts of a content item are fully functional on their own
- **adaptable:** the resource can be modified, for instance from a configuration file, from a plain text file or because it is provided along with its source code or an authoring tool.

It was later suggested that cross-border reuse of content will be more likely if resources:

- have a visual element and users can broadly understand what is the intended learning objective or topic (e.g. resources may have little or no text; and include animations and simulations that are self-explanatory or have just a few text labels or icons/buttons for start, stop, etc.)
- have been designed to be language customizable ('choose a language option') and are already offered in more than one language.
- address curriculum topics that could be considered trans-national (e.g. teaching 'geometric shapes' or 'the parts of the cell' are usually covered in every national curriculum but teaching the folklore of a very specific region is not).
- are adaptable from a technical (e.g. resources are supplied along with an authoring environment or tools) or IPR perspective (e.g. they are not made available under a "No derivatives" Creative Commons license which would prevent users from even translating the resource).

⁶ <http://info.melt-project.eu>

2.2.3 Hewlett OER Teachers' Network Project

Work on 'travel well' criteria was also conducted in a small feasibility project⁷ funded by the Hewlett Foundation where feedback was obtained from teachers both in Europe and internationally (in Australia, Africa and the USA). See Table 1.

Table 1. Travel well 'features' from the OERTN project

Travel Well Features		
Quality	Culturally appropriate	<i>The resource respects the cultural and social norms of the teacher and/or pupil.</i>
	Current	<i>Information contained in the resource is up to date or provided in real time (e.g. data feeds, news)</i>
	Authentic	<i>The resource relates to 'real-life' contexts or scenarios that are recognized by and may motivate the user.</i>
	Interactive	<i>The resource invites or requires a significant degree of user input or engagement, other than just reading something on a page and responding to it.</i>
	Advertising free	<i>The resource is free of any explicit advertising messages or corporate logos.</i>
Usability	Attractive	<i>The resource is visually appealing and well designed.</i>
	Engaging	<i>As well as being of immediate interest for some reason, the resource holds the attention and interest of users over a longer period.</i>
	Easy to navigate	<i>User can find their way through the resource almost intuitively. This may be possible even if the user is unfamiliar with the language of the resource.</i>
	Relevant to curriculum (even if not designed specifically for a given curriculum or for any curriculum)	<i>The resource lends itself to helping deliver what a teacher wants or is required to teach.</i>
	Adhere to W3C accessibility	<i>The resource follows W3C guidelines so that users with disabilities can understand, navigate and interact with the resource.</i>
Adaptability	Modular	<i>Even if the resource is quite large or complex, it has a well-defined structure and includes some sections or units that might 'travel well' because they can easily be extracted or "taken out" of the page or resource itself.</i>
	Content independent of structure	<i>Text in a learning resource can be easily modified without having to modify graphics or any multimedia components.</i>
	Language independent or multilingual	<i>Resources have very little text that requires translation or there are different language versions of the resource.</i>

⁷ <http://oertn.eun.org>

		<i>Such resources may have a strong visual element and may make extensive use of icons, images, maps, videos, animations etc. Or a resource where it is possible to insert key words in another language.</i>
	Remixable	<i>Digital resources that lend themselves to being adapted and combined with others (i.e. not a pdf file)</i>
Technical	Easy to download and save	<i>No technical, IPR or other issues that prevent a user from downloading a copy of the resource and storing it on their computer or elsewhere.</i>
	Stored as a file type that is readily accessible with generally available software	<i>For example, a common file type such as pdf, jpeg etc.</i>
	Cross browser compatibility	<i>The resource can be viewed in the all popular browsers.</i>
	Accessible without need to login	<i>Users are not required to login to a content repository, learning platform etc. in order to view the resource.</i>
	Unlikely to be blocked by firewalls	<i>There is little possibility that the resource cannot be viewed because it triggers content filtering software in the users' computer network.</i>
Openness	Degree of openness (e.g. rights)	<i>Resources have more potential to 'travel well' if they have an open license that places minimal restrictions on how the resource can be adapted, remixed, reused.</i>
	No cost to use	<i>Resources are completely free to use.</i>
	Labeling	<i>Resources contain metadata that adequately describe the resource and how it can be used. This includes metadata applied by both experienced indexers, teacher-generated metadata (ratings, tags) and metadata related to usage (e.g. downloads).</i>
	Indexed for searchability	<i>Resources in repositories should be open to being indexed by Google and other search engines.</i>
	Time limitations	<i>The resource can be assessed by users relatively quickly (difficult if it is extremely large or complex). No limitation applies to the period of time when the user can view or use the resource.</i>

3 Case study: European Learning Resource Exchange Service Validation in Lithuania

The FP6 CALIBRATE (CALIBRATE, 2008) project⁸ was one of the most significant European scientific research projects aimed focussed on the interoperability and exchange of K-12 learning resources. The usability of the CALIBRATE portal (containing nearly almost 100,000 learning resources) was evaluated in Lithuania in autumn 2007.

During the validation, Lithuanian teachers were asked how they intended to use I CALIBRATE learning resources. The results from the survey showed that most of the participating teachers had been using the LO: as an illustration or had included it in a presentation (i.e., as a learning asset) (88%), in project work (78%); as background information (76%); or had included the LO in a test/task sheet (66%).

The project results also showed that the majority of the teachers preferred to reuse 'small' learning assets, and they intended to reuse the majority of assets in another way and in another learning context than was primarily designed by the developers. The findings in CALIBRATE also confirmed that learning resource reusability is one of the main criteria for 'quality in use' evaluations of learning resources (Kurilovas, 2009a; 2007; Kurilovas, Dagiene, 2008; Dagiene, Kurilovas, 2008).

3.1 The Comprehensive Set of Criteria for Learning Objects Technological Evaluation

While analysing the aforementioned learning resources evaluation criteria (Kurilovas, 2009a; 2007), it was necessary to exclude all evaluation criteria that did not deal directly with learning resources technological quality problems on the one hand, and to estimate interconnected/overlapping criteria on the other.

This analysis has shown that all analysed sets of Learning resources evaluation criteria have a number of limitations from technological point of view:

- LORI, Paulsson and Naeve and MELT criteria do not examine different LO life cycle stages.
- Q4R set of criteria insufficiently examines technological evaluation criteria before LO inclusion in the LO repository.
- All these criteria insufficiently examine LO reusability (incl. Interoperability).

The nationally recognised Lithuanian set of Learning resources evaluation criteria also has a number of limitations (Kurilovas, 2009a, 2007; Kurilovas, Dagiene, 2008):

- All Learning resources and services (such as LORs, VLEs) are evaluated against the same criteria.
- No international standards compliant metadata related criteria are included.

⁸ <http://calibrate.eun.org>

- These criteria for e-content, e-activities and e-services do not reflect their reusability aspects overall.

It is obvious that a more comprehensive set of criteria is needed for the evaluation of learning resources from a technological perspective. This comprehensive set of criteria should include LO quality evaluation criteria suitable for different LO life cycle stages, including criteria before, during and after LO inclusion in the repository as well as LO reusability criteria (Kurilovas, 2009a, 2007; Kurilovas, Dagiene, 2008). LO reusability criteria should also have the same weight as the other criteria (Kurilovas, 2009a).

Therefore, a comprehensive set of technological evaluation criteria was proposed. This set of criteria is based on the flexible e-learning system approach as well as on the analysis of previous LO quality evaluation criteria. It combines LORI, Paulsson and Naeve, MELT, Q4R and the other research results published in (Kurilovas, 2009a, 2007; Dagiene, Kurilovas, 2008; Kurilovas, Dagiene, 2008).

This comprehensive set of criteria includes technological evaluation criteria suitable for different learning resource life cycle stages (before, during and after LO inclusion in the LOR), as well as LO reusability criteria. It combines both 'internal quality' criteria suitable for all learning resources (such as 'Interoperability', 'Architecture', 'Working stability') and 'quality in use' criteria suitable for the particular projects or groups of learners. Therefore, this set of criteria is suitable for the expert evaluation of learning resources 'quality in use' as well as the 'internal quality'. Teachers and learners are designated as the main users groups here. This original set of criteria is presented in Table 2.

Table 2: Technological quality evaluation criteria of learning objects (Kurilovas, Dagiene, 2008)

Criteria before LO inclusion in LOR	Narrow definition compliance			
	Reusability level: interoperability	<i>Metadata accuracy</i>		
		<i>Compliance with the main import/export standards (IMS)</i>		
	Reusability level: decontextualisation	<i>Is LO indivisible (atomic)?</i>	<i>LO aggregation (granularity) level</i>	
			<i>Is LO modular?</i>	
		<i>Does LO have a strong visual element?</i>		
	Reusability level: cultural and learning diversity principles	<i>Is LO flexible (can be modified)?</i>		
		<i>LO suitability for localisation</i>		
		<i>LO internationalisation level</i>		
	Reusability level: accessibility	<i>Is LO designed for all?</i>		
		<i>Compliance with accessibility standards (W3C)</i>		
	LO architecture	<i>Is LO architecture layered in order to separate data, presentation and application logics?</i>		
Working stability				
Design and usability	<i>Aesthetics</i>			

		<i>Navigation</i>
		<i>User-friendly interface</i>
		<i>Information structuring</i>
		<i>Personalisation</i>
Criteria during LO inclusion in LOR	Membership of contribution control strategies	<i>Using LO harvesting</i>
		<i>Obligatory membership</i>
	Technical interoperability	<i>Automatic verification of capability with known protocols</i>
		<i>Automatic metadata generation or simplified metadata tagging</i>
Criteria after LO inclusion in LOR	Retrieval quality	<i>User should be able to retrieve LO in different ways</i>
	Information quality	<i>Display information strategies</i>
		<i>Feedback techniques</i>

The additional LO evaluation criteria interconnected with technological criteria could be as follows (Kurilovas, 2007):

- Licensing (clear rules, e.g. compliance with Creative Commons).
- Economic efficiency (taking into account probable LO reusability level).

3.2 Pedagogical and IPR Criteria for Evaluation of Learning Objects

So far, EUN has identified some “travel well” parameters:

- Language independence / Low language dependence (easily translatable) or Multilinguality
- Strong visual structure (animations, images and short videos travel best)
- No large semantic density (easy to include in any curriculum) (Panzavolta, 2009).

Other parameters more relating to quality in general:

- Cultural appropriateness: the resource respects the cultural and social norms of teacher and / or pupil
- Usability: users can find their way through the resource almost intuitively. This may be possible even if the user is unfamiliar with the language of the resource
- Technical features: easy to access (no login or plug-ins)
- Openness: open license, free to use, open code (as in Flash resources) (Panzavolta, 2009).

We see a very wide range of Learning resources quality evaluation criteria presented here, most of which deal with pedagogical and IPR issues. In section 4, we look at a different approach, namely that of social tagging and how it can be used to describe usage, attention, and other aspects of the learning context. Our aim is to use this information to understand better whether how this information can be used towards selecting “travel well” resources.



Figure 1: Quality evaluation parameters (Panzavolta, 2009)

4 Study on contexts in tracking usage and attention metadata and tags in multilingual Technology Enhanced Learning

“Context” is widely accepted to be important for correctly interpreting user input and for improving predictive and possibly also diagnostic models. But what is context, and how can it be measured? By measuring we mean to operationalise the construct and data gathering to provide values for the desired variables.

In this study, we consider the intersection of the areas of digital learning resource repositories, digital libraries and social tagging systems where users from a variety of countries use technology enhanced learning (TEL) offerings in a variety of languages. We consider usage and attention metadata as an example of the wider notion of context, adapting the definition of context as “any information that can be used to characterise the situation of entities” (Dey, 2001).

TEL and the analysis of the data it generates take place in different types of educational settings which we call the macro-context of TEL. We use the term micro-context to denote the context that is relevant for interpreting a specific user input and for designing adequate system responses and other output. The micro-context is subdivided into user models, material/environment models, interaction models, and background knowledge, showing that usage and attention metadata are of different types and play different roles for learning about context.

The term micro-context is used to denote the context that is relevant for interpreting a specific user input (e.g. a search term) and for designing adequate system responses and other system output. Micro-context may be provided by the activities themselves, the user (model), or further background knowledge, often referring to the LO. In each case, the question arises how to measure these variables. For many types of (meta)data available in electronic environments, it is rather straightforward to determine whether they relate to an activity, a user, or the material itself. Tags are an interesting exception: at first sight, a tag may be thought of as just another feature of the object (e.g. LO). However, this view ignores the essential role that the user takes when tagging. Tags and the resulting networks (folksonomies) are commonly modeled as tripartite hypergraphs, e.g. (Cattuto et al., 2007). This means that they are formed by triples of (user,item,tag). For analyses, this ternary relational structure is often projected to a lower-dimensional space. This gives rise to (item,tag) relations that – for our purposes – allow tags to be part of the LO as context. By looking at the (user,tag) relation, one obtains tags as part of user models – which may for example be leveraged to infer preferred language(s) of the user. Additionally, an investigation of the (user,item) relation can give important clues to the user’s LO preferences. The full relational structure emphasises that tags may also be regarded as a parameter of the interaction between a user and the LO.

4.1 Interaction as context – parameters of interaction for measuring context

This view of context regards a user action that is an interaction with a material as an atomic unit of analysis (such as clicking a hyperlink, giving an answer in a multiple-choice question, or downloading a document). This action is associated with certain parameters/metadata: date and time including access time and dwell time; action type such as download, insertion, viewing; query terms; IP address; operating system, browser and further technical characteristics of hardware and software; the application or tool used including its name, URI, type such as LOR or LMS (e.g. Najjar et al., 2006, Brooks & McGalla, 2006). We call such information “implicit interest indicators” because it is collected non-reactively (Claypool et al., 2001) without intruding on the user. In contrast, “explicit interest indicators” are derived from users (more) consciously expressing their interest in LOs. Explicit interest indicators include tags, ratings, and bookmarks. They can give rise to metadata describing the user’s/learner’s perspective on the LO including feedback on it or knowledge of the content. Both implicit and explicit interest indicators can be regarded as atomic, or in the context of a complex activity such as a session or search episode (which may be a sequence of atomic interest indicators with different values). We first describe the atomic versions and subsequently their use in activity structures.

4.1.1 Atomic implicit interest indicators

Attention metadata in the technology enhanced learning (TEL) context for enriching LO metadata in LOR and LMS are studied in Najjar et al. (2006). The idea is to capture the attention metadata about the user’s actions across system boundaries to enable better targeted personalisation of learning services (e.g. Recommender systems). The authors propose a Contextual Attention Metadata framework that is based on the exchange of information using an extended version of AttentionXML. Wolpers et al. (2007) complement the concept of tracking user’s attention (e.g. when, how long, in what sequence have this taken place) across applications that are used regularly in TEL (e.g. Office Suite, Web Browsers, Mail Clients). The authors suggest that contextualised attention metadata schema enables the correlation of the observations, thus reflecting the relationships that exists between the user, her context and the content she works with best. This type of concept seems important especially for informal learning, where learning rarely takes place using institutionalised learning platforms or learning management systems. Khoo et al., (2008) investigated the use of session length (derived from the times of the session’s clicks) as a metric for digital-library site performance. They report that this metric can be very misleading in the context of digital libraries (as opposed to e-commerce), as the relationship between session length and web site quality is a contextual relationship; for some sites, short sessions might be indicators of quality; while for other sites long sessions might be indicators of quality.

4.1.2 Atomic explicit interest indicators, in particular tags

Cattuto et al., (2007) found that folksonomies are highly connected and that the relative path lengths are small, which facilitates the “serendipitous discovery” of new content and other users. Tags have therefore become popular as clear-cut indicators of interest

and a basis for recommendation. For example, Santos-Neto, Ripeanu & Iamnitchi (2008) track user attention in collaborative tagging communities for academic papers in order to harness usage patterns to improve navigability in a growing knowledge space. They find a clear segmentation of interests into a significant number of small sub-communities of interests that are totally separated from each other and further suggest methods for building efficient, online recommendation systems for tagging communities.

4.1.3 Activity structure

Actions generally do not take place in isolation, but in sequences or parallel threads. When previous or parallel other actions provide information for interpreting an action A, we say that the activity structure provides context (for A). Implicit relevance feedback provided by click data on a university document search system was studied in Jung, Herlocker & Webster (2007). They found that considering all the click data in a search session as relevant feedback can increase both precision and recall ; however, for high precision, focusing on last visited documents could be more useful. Santos-Neto et al., (2009) focused on individual and social behaviour in tagging systems. They show that individual need for organising content is a stronger motivation for tagging than collaboration with others to categorise the content. They also found low reuse of previously tagged items which leads to sparse datasets. However, they conjecture that the lower segmentation of tag-based interest sharing allows for content discovery, thus leveraging pair-wise tag-item comparison rather than user-item. Similar findings have been reported by Vuorikari, Poldoja & Koper (2010) who compared over 20,000 tag applications from five different educational-content platforms. The authors showed that 30% of tag applications overlap through a tag in two or more content platforms, which allows for the discovery of content across platforms.

Vuorikari, & Koper (2009a) focused on using attention metadata produced from users' interactions within a learning resources repository where they search, play, rate and bookmark learning resources. The following events had been recorded: session, search (different kinds), click (LO, tag, rating, user), bookmark, tag, rating. These were used to model how users behave on the portal, how they search in different ways (e.g. using conventional search or community browsing using tags), what do they click on and how do they find relevant resources. Moreover, the attention captured from users was used to calculate a user's efficiency in using different search methods. It was found that users spent less search effort and clicks to find relevant resources using "community browsing" and social information from other users.

4.2 The user as context – user models for recording context

As argued in the previous part, tags and other explicit interest indicators can give much information about a current action, and their re-use can be part of models of activity structure. Aggregations over tags created by one user in different activities may also give more "persistent" information about that user. How user modelling can take advantage of personal tags and tagging data in general has been a focus of research; Au Yeung, Gibbins & Shadbolt (2008) conclude that the majority of users of tagging systems possess multiple interests and propose a way to reflect that in user profiles,

and Michlmayr & Cayzer (2007) base their user model on tagging behaviour for the reason that it can adapt over time.

Vuorikari & Koper (2009b) used bookmarking and personal Collections of digital learning resources as a proxy for the use and reuse of digital learning resources across national and language boundaries. For each user in question, the country of origin and mother tongue were considered, and compared to the country of origin or language of the learning resource that they had bookmarked. This method was used to measure the use and reuse in different contexts, i.e. across boundaries. The authors confirmed previous studies that the reuse within the systems was rather low (around 20%) and that it correlates strongly and significantly with the reuse across national and language boundaries, which was even lower.

4.2.1 Country and language

Country and language may be operationalised in different ways depending on the domain and the analysis questions. Country of birth and mother tongue are essentially persistent user traits, whereas the country a user works in as well as preferred languages may be persistent or transient traits. Vuorikari & Koper (2009b) studied the use of learning resources in repositories where the country in which the user (e.g. teacher) works was used to infer certain features of the resource (e.g. how well it could be used in a new context, alignment with national curriculum). Knowing whether the user accesses information in a first or in a second language – irrespective of the language itself – leads to an operationalisation of language as a variable depending on the relation between user and material Berendt & Kralisch (2009). In Vuorikari & Koper (2009b) the user variables country and language were given by self-profiling information. These variables may also be inferred from the automatically measured logfile variable IP address. For example, in Berendt & Kralisch (2009) it was used for an investigation of the effects of language on usage behaviour and attitudes towards a content portal. Further possible clues are the browser settings (self-profiling); the language of the currently used interface where the service is available in different languages; and the language of search terms and tags (user input). For the latter, however, recognising the language is a challenge, as usually only one or a few terms are used. A language classifier taking advantage of dictionaries can be used to predict the likely language of a user input. Additionally, information given by using the other above methods has been investigated in Vuorikari & Ochoa (2009). In social tagging systems, for example, the known or inferred languages of tagged resources can give further hints as to the user's preferred language(s).

4.3 Background knowledge, especially related to the LO, as context

Background knowledge is pre-existing knowledge about materials, users, etc. An example in TEL is the use of Semantic Web techniques for interpreting an action by Brooks & McCalla, 2006. They formulate cognitive-behavioural models in RDF, combine a domain ontology (of the topic domain to be learned) and an educational objectives' ontology. The Semantic Web architecture allows a flexible association of data on usage with such background models of learner behaviour and competencies.

Standard, expert-provided background knowledge may also be enriched by tagging. Vuorikari et al., 2009 studied tags for the purpose of enriching existing metadata of educational resources in a multilingual context. They found that user-generated tags were in general of good quality ; 30% of tag applications matched descriptors found in a multilingual thesaurus, which had also been used to index these learning resources. The authors argue that these tags, called “Thesaurus tags” provide a bridge between tags and multilingual Thesaurus descriptors, thus creating relationships between descriptors and tags. This allows linking to related Thesaurus descriptors in multiple languages and further supports the retrieval of resources in a multilingual context. Moreover, “Thesaurus tags” make it possible to add properties to tags (e.g. relation to a concept in multilingual Thesaurus, language). Bateman, Brooks & McCalla (2006) define an alternate method to this, a way to annotate learning objects with metadata, while providing enough semantics through an ontology like WordNet.

4.4 Exploiting context information for a better multilingual support

A good example of the use the knowledge about a user’s language context is the provision of a better-organised search result list: first a ranked list in the preferred language, then a ranked list in a second language, and so on. Such interface choices are currently made by Google for general search results and by LeMill (lemill.net) for LOs. A related exploitation of the user’s language context is to organise tag clouds by language or country as in the LRE (lreforschools.eun.org), rather than to overwhelm users with tags in all languages.

These strict separations are especially suited for users with a strong preference for one language, e.g. the only language spoken, or if user has a preference for uni-lingual content. In Vuorikari & Koper (2009b), for example, it was found that 17% of users had saved only content in their native language in their Favourites. In Vuorikari & Ochoa (2009), it was shown that exceptions can become interesting for travel-well tags, which are terms with the same or similar spelling in most languages (e.g. technical terms like “mathematics”, place and person names). These become an interesting option particularly for a less used language or if the user is unknown. Identification of travel-well tags may be done by using a dictionary, such as a multi-lingual thesaurus. However, they are also a good example of the multifaceted role of tags: a tag can be classified as travel-well based on the context and tagging metadata. i.e., if users from at least two different languages have assigned this tag, or if the tag has been assigned to learning resources that are themselves in more than one language. Travel-well tags have a counterpart in resources: travel-well resources are those that have been bookmarked by people speaking different languages, but also from different country contexts, indicating that the resource can be useful regardless of its context.

Information on a user’s language, or the language that s/he currently uses for example to browse the web (this information can be inferred from the browser) may also be used to give query recommendations. For example, Bianco & Lioma (2009) found that Latinized versions of search terms often gave worse results than the correct, language-

dependent spellings. Encouraging users to use their own language rather than English may therefore help them get better search results.

Knowledge on users language contexts can be leveraged in recommendations on content or input in direct ways as shown above, by recommending content or tags in a preferred language, or in indirect ways, for example by recommending the bookmark list of other users with a similar “language preference profile” (including the degree of tolerance for mixed-language resources, results, etc.). Finally, repositories could specifically encourage users who are competent in “minority” languages also to author content in their language. This could help counter the manifold and mutually reinforcing mechanisms on the Web that discourage non-English languages (Berendt & Kralisch, 2009).

5 Initial identification of future criteria

The key challenge in the eQNet project, like in any other case where models are constructed, is how to establish a ‘proper’ set of evaluation criteria reflecting agreed principles for such work. Such general principles have been analysed in several multiple criteria decision analysis (MCDA) related works such as (Belton, Stewart, 2002).

An initial candidate set of key factors (i.e. *criteria*) should emerge from the problem structuring process. In identifying these, the following considerations are relevant to all multiple criteria decision analysis approaches (Belton, Stewart, 2002).

- *Value relevance*: Are the decision makers able to link the concept to their goals, thereby enabling them to specify preferences which relate directly to the concept?
- *Understandability*: It is important that decision makers have a shared understanding of concepts to be used in an analysis.
- *Measurability*: All MCDA implies some degree of measurement of the performance of alternatives against specified criteria, thus it must be possible to specify this in a consistent manner. It is usual to decompose criteria to a level of detail which allows this.
- *Non-redundancy*: Is there more than one criterion measuring the same factor? When eliciting ideas, often the same concept may arise under different headings... One can easily check for criteria which appear to be measuring the same thing by calculating a correlation coefficient if appropriate data is available, or carrying out a process of matching as associated with analysis of repertory grids.
- *Judgmental independence*: Criteria are not judgementally independent if preferences with respect to a single criterion, or trade-offs between two criteria, depend on the level of another.
- *Balancing completeness and conciseness*: a number of authors note that desirable characteristics of a value tree are that it is complete, i.e., that all important aspects of the problem are captured, and also that it is concise, keeping the level of detail to the minimum required.
- *Operationality*: The model is usable with reasonable effort – that the information required does not place excessive demands on the decision makers. The context in which the model is being used is clearly important in judging the usability of a model.

(In the other words, the principle of ‘Operationality’ means that the evaluation model, or a set of criteria, should not require from decision makers unreasonable time or knowledge to perform the evaluation. This means that, e.g., the model should consist of a reasonable number (e.g., < 20) of clearly measurable and independent criteria, and therefore it should take a reasonable time (e.g., < 20 min) for the average statistical expert to evaluate the resource.)

- *Simplicity versus complexity*: The value tree, or criteria set is itself a simple representation, capturing the essence of a problem, which has been extracted from a complex problem description. The modeller should strive for the simplest tree which adequately captures the problem for the decision maker (Belton, Stewart, 2002).

5.1 Overall Evaluation Model for learning resources

In order to establish an objective scientific model (set of learning resources' quality evaluation criteria), we should apply general criteria identification principles presented earlier to the learning resources technological, pedagogical and IPR quality evaluation criteria.

Table 3 is an attempt to present some kind of a learning resources' quality evaluation model consisting of eight quality criteria, four of them dealing with technological quality, three – with pedagogical quality of learning resources, and one with IPR issues.

Table 3: Overall quality evaluation criteria of learning objects

Type of criteria	Sub-type of criteria	Criteria	Sub-criteria
Technological criteria	'Internal quality' criteria	Reusability	<i>Interoperability (metadata, packaging standards)</i>
			<i>Aggregation level, modularity</i>
			<i>Internationalisation / localisation level</i>
			<i>Accessibility</i>
		Architecture	
	Working stability		
	'Quality in use' criteria	Design and usability	<i>Aesthetics</i>
			<i>Navigation</i>
			<i>User-friendly interface</i>
			<i>Information structure</i>
<i>Personalisation</i>			
Pedagogical criteria		Interactivity, strong visual element	
		Language independence	
		Easy to use, intuitive	
IPR criteria		Open license, free to use, open code	<i>Cost</i>
Evidence of use		Information collected from the real usage	<i>Context data from the user and usage</i>

6 Conclusion and future work

The aim of this first part of research within the eQNet project has been to review relevant work regarding the quality and evaluation of Learning Objects (LOs) in the two complimentary areas of research, one focusing on expert evaluations of the LOs and the other looking at end-user driven approaches that rely on social tagging. The research results presented in this first deliverable indicate that there may need to be a complex application of different methodologies including: multiple criteria decision analysis for identification of quality evaluation criteria; technological quality criteria classification principles; fuzzy group decision making theory to obtain final evaluation measures; normalisation requirement for the weights of evaluation criteria and scalarisation method for LOs quality optimisation⁹.

The aim in subsequent deliverables is to confirm our initial conclusions that these methodologies are:

1. applicable in the real life situations when schools have to decide on purchase of LOs for their education needs, and
2. could significantly improve the quality of the expert evaluation of LOs by noticeably reducing the subjectivity inherent in expert evaluations.

In addition, as the second part of the D 2.2.1 highlights, there is a growing body of evidence which suggests that a user-driven, social tagging approach can help operationalise acquired contextualised information in order to support the reuse of content in different linguistic and national contexts.

Moving forward, the eQNet project will investigate how these two different though complimentary models/methods for evaluating the “travel well” potential of LOs, can help project partners identify this sort of content in the LRE.

All models, of course, need validation. In eQNet, a wide-ranging validation (paying special attention to reusability and the ability of resources to ‘travel well’) of the presented model and methods is an on-going work by WP3, involving European Schoolnet and the nine participating European Ministries of Education in the project. The second phase of this work, starting from October 2010, will use the model and work towards its validation, which will be reflected in the version 2 of the criteria (D2.1.2). After successful fine-tuning and a wide-range validation, the models can become tools suitable for practical evaluation of LOs used by European policy-makers, publishers, practitioners (e.g. teachers and learners) and expert evaluators.

⁹ Both “normalisation requirement” and “scalarisation method” are not explained in the deliverable. These notions deal with the larger notion of evaluation method, however, this deliverable is only about the evaluation model (i.e., set of criteria).

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